mines; to-day, after many experiments with compressed powder, cotton-powder, and other such compounds, and after nitro-glycerin had been tried and given up because of its danger, only such "high explosives" as dynamite, gelignite, and the like are used. These high explosives only came into use after much experimenting, by the Royal Cornwall Polytechnic Society in particular, but they have proved themselves very serviceable, especially in hard ground, and they are also found to be much safer in use than the old black powder.

Great improvements have been effected in the machines used for compressing the air employed in working the machine-drills; compound engines, compressing the air in successive stages, are now generally employed in the larger mines.

Compound engines, mostly of the tandem type, were introduced into several Cornish mines by Mr. Sims more than half a century ago, but with the low-pressure steam then employed did not recommend themselves, and so went out of use. A compound engine using high-pressure steam has been employed for years past in pumping at the Basset Mines for working the ordinary force pumps; of late many attempts have been made to introduce centrifugal pumps operated by electricity for draining the mines. A certain measure of success has attended these efforts, particularly at the Tywarnhaile Mines, and more recently at Wheal Vor; but it must be admitted that up to the present the Cornish system of pumping, the rods being operated by a simple vertical engine, single acting in the case of large installations, holds the field.

The use of electricity is spreading in the Cornish mines apart from pumping. At East Pool it has long been employed for surface traction, the mill being a mile or more away from the mine. At South Crofty it is employed for operating the new stamp mill; in several mines it supplies power to work pulverisers, buddles, and other dressing machines, and in this direction—as also in electric lighting—there is a large field for extension.

There have been great improvements in the engines used for winding during the past few years. It no longer takes thirty to forty minutes to raise a kibble of stuff from the bottom of the deeper mines, as it did at one time; skips running between guides are now common, cages bringing the ore-wagons direct to surface are employed in several mines, while the men are mostly brought up from below in shaft-gigs or special skips, so that the man-engine, once so great a boon and used in no fewer than twelve mines, can now only be seen in operation in the Levant Mine. For modern winding wire-ropes are universally used, and are practically indispensable. Accidents from its use are, indeed, exceedingly rare. Mr. Morgan's traversing engine, erected some years since for hoisting from Williams's Shaft at Dolcoath, will soon be at work again, but so far no proposals seem to have been made for using this remarkable engine anywhere else.

For signalling in shafts the old "knocker line" is still in use, and has its advantages. Indicators for the guidance of the engine-man are, of course, placed in the engine house in every case where men are raised, and in most other cases; overwinding is an extremely rare occurrence, such is the carefulness of the engine-man. The telephone was introduced in Wheal Eliza by Dr. Le Neve Foster many years ago for signalling from below, but it did not "catch on." It is, of course, used for ordinary business purposes in several of the mines.

The steam-boilers used in Cornwall are mostly of the Cornish or Lancashire type, and work at comparatively low pressures. The number of these boilers working above 60lb. is not very great, and those working at 100 or more could almost be counted on the fingers. Multitubular boilers, portable or semi-portable, are used in some instances where good water is obtainable, and particularly for winding, while the electrical pumping plant at Tywarnhaile is worked by engines which consume "suction gas."

Many improvements have been introduced in the treatment of ores: the ores treated in Cornwall now are almost exclusively of tin, copper ore being rare, while the working of iron, lead, and zinc ores has practically ceased.

The first crushing is generally done by stonebreakers of the Blake type, followed by stamps of the Cornish, California, or pneumatic type, the "rows" being finally reduced by some form of pulveriser. Self-feeders have not yet been used for the Cornish stamps, but they are always employed in connection with the California and pneumatic stamps. At Dolcoath powerful batteries of all three types can be seen regularly at work.

For dressing the crushed ore, while buddles are still very generally used at some stages, Wilfley, Buss, or other tables of the percussion type, or Frue vanners are employed in most of the larger mines. Hydraulic separators are mostly used to remove the slimes before feeding the pulp to the Wilfley and Buss tables, but in the case of the Frue vanner the slimes are generally removed for separate treatment at a later stage.

For slime treatment there is still nothing better known than the dead-frame, the ordinary round slime table, or the Acme table. The old-fashioned swinging rack for cleaning slime has practically disappeared, though it had some notable merits.

Most tin-ores need calcination before they can be cleaned for the market. In some of the smaller mines the old reverberatory oven is still in use, but in the larger mines the Brunton revolving calciner is always employed.

The calcination of tin-ores yields in some mines large quantities of "arsenic-soot," which is collected in long flues of masonry; this soot, at one time valueless or worse, is now an important by-product. It is handled by the ton as freely as sand, and apparently with equal impunity for cases of arsenic poisoning are far rarer in Cornwall than in London. Another important by-product in some mines is wolfram, which at one time was merely a deleterious component of the dressed tin, but is now profitably extracted at many of the mines, and in particular at Clitters United, East Pool, and South Crofty by means of the Wetherill magnetic separator. In this machine the powdered and thoroughly dried concentrates are carried slowly over electro-magnets on traversing belts. The magnets remove the slightly magnetic particles of wolfram, while the non-magnetic particles of cassiterite pass on and fall into a separate receptacle. The wolfram so separated in most cases still contains a considerable percentage of tin-oxide. At the mines mentioned this tin-wolfram product is "pickled" with dilute acid (aided by jets of steam at East Pool) in order to remove certain highly magnetic iron oxide components, which seriously interfere with the operation of the magnetic separator. A similar "pickling" was recommended by Dr. Richard Pearce forty years ago, and has occasionally been used for the removal of copper from calcined tin ores.

At Tynwarnhaile, and also at Dolcoath, the Elmore oil processes have been, or are being, introduced for the concentration of low-grade copper ores. The wet ore-pulp is mixed with oil and subjected to a partial vacuum, by which means the ore-particles are floated up from the waste as a sort of mineral scum, which is readily separated from the waste, and with much less loss than is the case by the methods hitherto employed.

Enough has been said in this hasty summary to show that the Cornish miner to-day, as in the past, is very ready to avail himself of such new methods and appliances as have a reasonable prospect of success, although it must be admitted that he is rather fond of letting other people experiment for his benefit.

J. H. COLLINS.

THE IRISH PEAT INDUSTRIES.[1]

ACCORDING to reports published in 1814 by the Bog Commissioners, Ireland possesses 3,028,000 acres of "peat bog," of which 1,648,000 acres form "available" or so-called "red bog," and about 1,380,000 acres form "mountain peat bog." The "red bog" is mainly confined to the great central plain of the island, and the "mountain bog" to the counties of Wicklow, Donegal, Mayo, Galway, and Kerry. As the accompanying outline bog map (Fig. 1) shows, there are few portions of the island destitute of bog.

The slow but continuous reclamation of Irish bogs which has been going on for the past three hundred years is referred to in a work written, in 1645, by Dr.

1 Abridged from the Economic Proceedings of the Royal Dublin Society, vol. i., part x. (July)

Gerard Boate. The method of reclamation practised in Ireland at the beginning of the seventeenth century, consisting as it did of draining the bogs and manuring the dried surface, was probably, owing to radical differences in detail between it and the Dutch fen reclamation process, of independent origin from the latter, which was introduced about the same time on the Continent at Groningen, in Holland, and at Emden, in East Frisia. At a later period—in the reign of William III.—the Dutch offered to introduce their system into Ireland upon condition of being allowed to establish a self-governing colony in the Queen's County.

The drainage and reclamation of the bogs have always been subjects of interest; the existence of so much unreclaimed land being a source of loss to the State, and its humidity being detrimental to the health of the community.

We find, for instance, a writer in 1660 recommending that "An Act of Parliament should be made that they who did not at such a time make some progress in draining their bogs should part with them to others that would," and about sixty-five years later an Act was passed

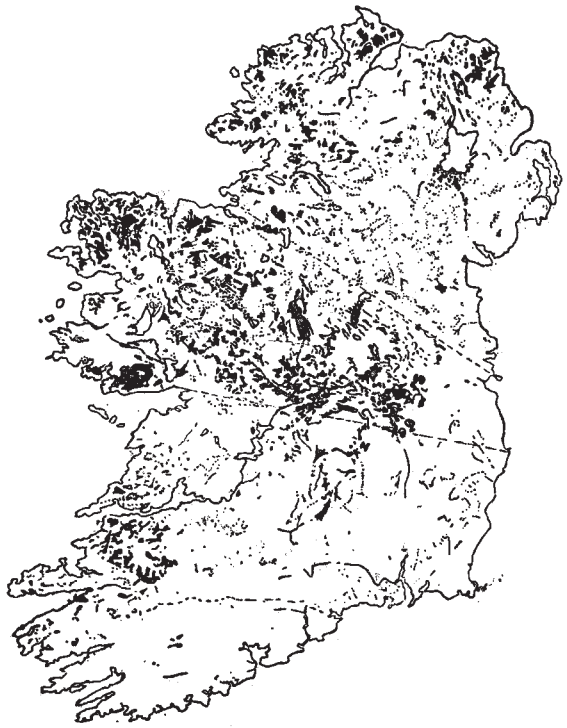

FIG. 1.—Outline bog map of Ireland.

by the Irish Parliament for the encouragement of the drainage of bogs.

Schemes for the drainage and reclamation by burning and manuring the surface of the bog, on the one hand, or by covering it with a layer of sand and manure after a due interval for subsidence, on the other, were published in 1814 in the reports of the Bog Commissioners. These reports described also the numerous successful plantations of trees in Irish bogs made during the eighteenth century. The engineers engaged in the work were of opinion that the bogs could be drained and converted into arable land without much expenditure of time or money.

It would be scarcely economic to attempt the reclamation of bogs the average depth of which is 25 feet, such as those in the central plain of Ireland, without first making a serious effort to utilise the "available" peat of the bogs. Apart from the large sum of 41,565*l.* expended in the years of the Bog Survey, there have been since that time smaller sums contributed by the State to the development of the peat industry. The Department of Agriculture, for example, has within the last few years spent upwards of 6317*l.* in experiments on the preparation of peat-moss litter and fuel. It employed the services of an expert to report upon the various Continental processes, and to select the machinery necessary for the carrying out of the experiments which were subsequently performed at Inny Junction, County Cavan, and at Castleconnell, County Limerick.

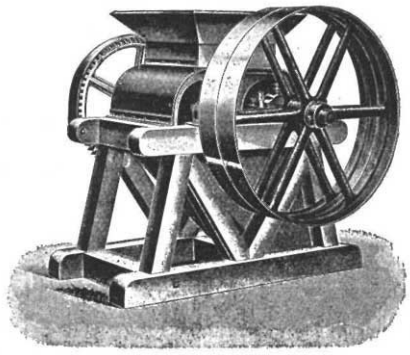

FIG. 2.—Dolberg's peat-moss litter dividing machine.

Within the past hundred years many attempts have been made in Ireland to utilise the peat supply. About the middle of the nineteenth century a turf-charcoal factory was established at Derrymullen by Rogers, but was, however, after a brief period of work, abandoned. A similar fate awaited the turf-distillation factory established in the year 1849 by Reece under the guidance of

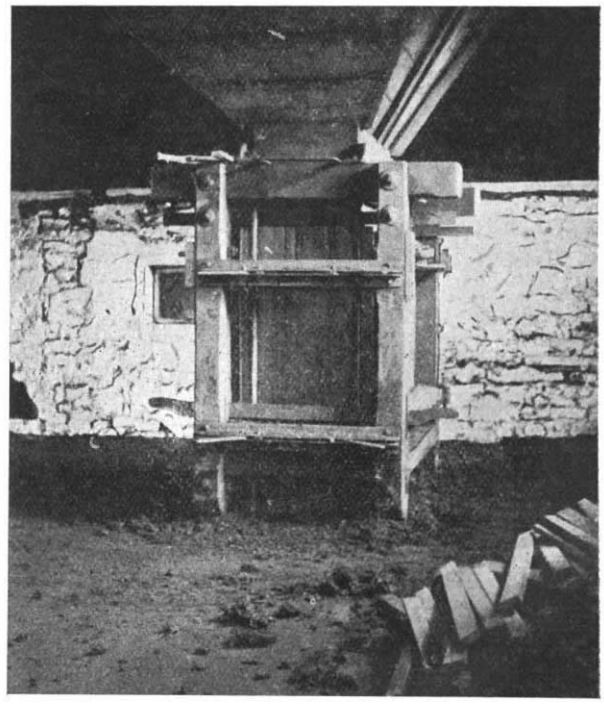

FIG. 3.—Peat-moss litter baler, Umaras, co. Kildare.

Sir Robert Kane at Kilberry, near Athy. Although a bright future seemed to lie before this factory, which was the first of its kind in Europe, it was, after a few years' active work, closed by its directors. In 1863 a process for the manufacture of "sieve turf" was worked on a large scale for a short time in connection with the Creevelea Iron Works near Sligo. At Derrylea, near

Portarlington, in 1866, several thousand tons of press turf were made by a modification of the oldest known "dry-press" process—that of Gwynne, which was itself tried on a small scale in 1855 at Kilberry. Of historical interest also is the fact that, of "wet-press" processes, one of the oldest found in the literature of peat is that which was employed by Williams in 1844 at Cappoge, in the Bog of Allen.

In recent years there have been built in Ireland many peat-moss litter factories, such as those at Umaras, near Monasterevan, County Kildare; at Coolaney, County Sligo; at Maghery, County Tyrone; at Ferbane and Rahan, King's County; and at Inchicore and Ringsend, in Dublin. The peat paper factory at Celbridge, County Kildare, belonging to the Callendar Paper Company, has recently been closed. At Umaras and Maghery there are peat-fuel factories, and at Kilberry a fuel called "electro-peat" is manufactured. Quite recently experiments have been carried out at Carnlough, County Antrim, on the production of ammonia from peat, and the installation of a

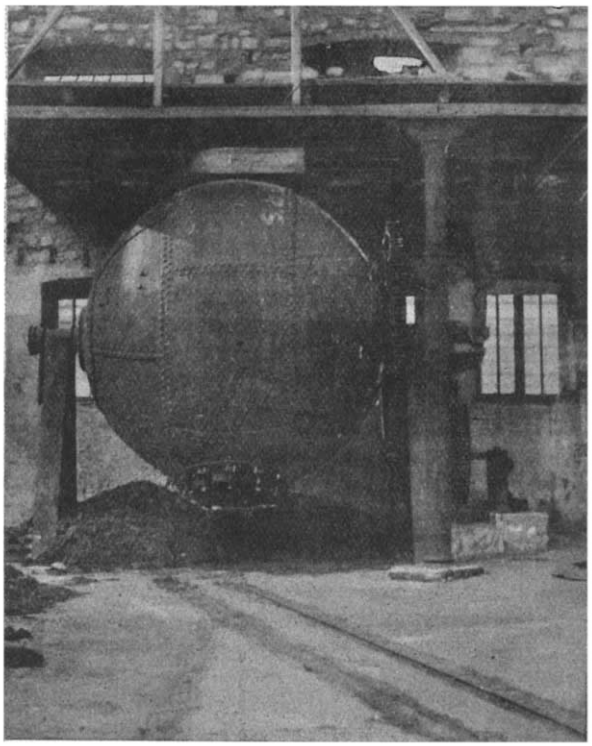

FIG. 4.—Peat digester, peat paper factory, Celbridge, co. Kildare.

plant capable of producing 5000 tons of ammonium sulphate per annum is now being completed at a cost of 85,000*l*.

It is convenient to divide the peat industries into three classes, namely, the fibre, the fuel, and the distillation industries. In this paper the first, and probably the most important, class will be considered more fully. In the peat-moss litter districts of Ireland the peat is dug out of the bog in large sods, which are dried in the air and stored under cover to prevent the re-absorption of water. The air-dried peat is next disintegrated by the rotating circular saws contained in the body of a dividing machine (so-called wolf, Fig. 2), sifted free from mould, and compressed into bales by vertical knee-lever presses, such as that used at Umaras (Fig. 3). From the "wolf," which is placed on the ground floor of the factory, the divided peat is carried by elevators to the upper floor, where, after passage through a cylindrical sieve, it is delivered into the funnel-shaped mouth of the baler. The mould can at the same time be collected apart. It is exported in large quantities by the owner of one of the factories to southern countries for the preservation and packing of fruit and vegetables grown there.

Where a suitable canal system exists the peat-litter industry is successful, but where canals are not available the industry is crippled by the high rates of carriage charged by the railway companies.

The purified peat moss can be used for the preparation of peat molassine meal and for the manufacture of alcohol, but as the latter process can scarcely at the present time be carried on remuneratively it is not practised in Ireland.

The peat paper factory which was established in 1903 at Celbridge, and turned out large quantities of wrapping paper yearly, was unsuccessful. It was finally closed in December, 1905. The peat, brought on cars from a bog situated at a distance of several miles from Celbridge, was subjected to a preliminary treatment in a large spherical revolving digester (Fig. 4), from which it was conveyed by cars running on a small iron railway to the scarifying and beating machine, where it was converted into pulp. After passing through sand-traps, the unbleached pulp was delivered on to an endless band, by which it was brought between the revolving rollers of a paper-pressing machine. The band of paper thus formed was glazed and polished by vertical rollers.

The motive power of the factory was electricity, which was generated in a dynamo driven by a 200 horse-power turbine worked by water from the adjacent Liffey.

The brown wrapping paper sold by the company was of a strong texture, excellent quality, and contained about 66 per cent. of peat fibre. Considering, however, the large amount of material present in crude turf which is useless for the manufacture of paper, it will be readily seen that the preliminary treatment of the peat should be carried out in the immediate neighbourhood of the bog.

The accompanying illustrations from the author's "Reports upon the Irish Peat Industries," part i., are reproduced by the courtesy of the Royal Dublin Society.

HUGH RYAN.

ZOOLOGY AT THE BRITISH ASSOCIATION.

The Physical Basis of Inheritance.

ONE of the most interesting features of the programme of Section D was a discussion, jointly with Section K, on the physical basis of inheritance. In opening the debate, Prof. S. J. Hickson, F.R.S., dissented from Montgomery's view that the inherited characters are transmitted *solely* by the chromosomes. The principal piece of evidence which is quoted in support of this hypothesis is Boveri's experiment (1889) in which an enucleate echinoderm ovum of one species, fertilised by a spermatozoon of another species, produced a larva with purely paternal characters; but similar subsequent experiments have not always resulted in a larva with purely paternal characters. Confirmatory evidence of the theory is held to be afforded by (1) the constancy in the number of chromosomes in the somatic cells; (2) the reduction to half the normal number of chromosomes in the sexual cells; and (3) the presence of similar heterogeneous chromosomes in the sexual cells of certain Arthropods and their mutual conjugation during fertilisation. If the theory be true, it appears necessary to hold that the chromosomes maintain their individuality, but there is convincing evidence that in some animals this is not the case, *e.g.* in certain Rhizopoda (*e.g.* Pelomyxa), Suctoria (*e.g.* Ephelota, Dendrosoma), and Cœlenterates. Moreover, if it be true that the cytoplasm of conjugating cells is not concerned in the transmission of hereditary characters, it is difficult to account for the long duration of the period of conjugation in Infusoria and the cases of fertilised enucleate eggs which produced larvæ with maternal characters. Prof. Hickson suggested a possible explanation, viz. that where the characters are comparatively rigid, as in mammals, insects, and some other groups, they are aggregated in definite masses, and may be associated with the chromosomes, but where it is advantageous for the characters to remain more variable they